Contribution ID: **57** Type: **not specified**

Signal shape studies and rate dependence of HFO-based gas mixtures in RPC detectors

Wednesday 11 September 2024 09:50 (20 minutes)

The RPCs employed at the LHC experiments are currently operated in avalanche mode, with a mixture containing a large fraction of C2H2F4 (> 90%) with the addition of i-C4H10 and SF6 in slightly different concentrations (depending on the experiments). However, C2H2F4 and SF6 are fluorinated greenhouse gases (F-gases) with GWP of ˜1400 and ˜22800 respectively. EU regulations imposed a progressive phase-down of C2H2F4 production and consumption, aiming at strongly reducing its emission. This is already resulting in an increase of its price and reduction in availability.

The most desirable long-term solution to this problem is to find an alternative, F-gases free gas mixture, able to maintain similar detector performance. To address this challenge, the RPC ECOgas@GIF++ collaboration (including RPC experts of ALICE, ATLAS, CMS SHiP/LHCb and the CERN EP-DT group) was created in 2019. The collaboration is currently studying a gas from the olefine family, the C3H2F4 (or simply HFO, with GWP˜6), to be used, in combination with CO2, a substitute for C2H2F4.

This contribution will focus on the signal shape studies that have been carried out by the collaboration during dedicated beam test periods. The methodology used in the data analysis will be presented, together with the results obtained with several HFO-based gas mixtures, compared to the currently employed one. Furthermore, results on the counting-rate dependence of the RPC performance, obtained by combining the muon beam with the GIF++ 137Cs source with different attenuation factors, will also be presented.

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Session Classification: Ecogases and longevity (part I)